ELECTROMAGNETIC SEATBELT ENERGY MANAGEMENT DEVICES

Field of the Invention

[0001] The present invention relates to seatbelts and devices or systems for limiting the loading of the passenger against the restraint of the seatbelt.

Background of the Invention

[0002] The evolution of car safety systems has gone from the simple lap seatbelt, followed by shoulder belts, to airbags and other active systems. In particular, the effectiveness of seatbelts can be improved by tightening the seatbelts with automatic seatbelt retractors in the early stages of a crash. As the forces produced by the crash push the vehicle occupants against the seatbelts, systems are available which allow the seatbelt webbing to extend to mitigate maximum crash loads. Such mitigation of maximum loads can result in higher survival rates and reduced injuries. Known mechanisms are relatively simple and involve stretching of the seatbelt webbing and the use of energy absorbing structure such as the shear shaft contained within the seatbelt webbing take-up spool. Modern methods of design, simulations, and crash testing have allowed the development of computer models and databases that can be used as design tools. These design tools are used to predict the injury which a vehicle occupant might be expected to suffer in a crash of a given magnitude with the safety systems of a particular design. Typically, the designer works with the parameters of available safety systems to try and optimize their functionality during a crash. However, a vehicle crash by its nature is to some extent an unpredictable event. The loads to which a vehicle's occupants are subjected vary dramatically between different crash scenarios. The designer's objective is to build a system which functions best in the majority of cases.

[0003] Typically the designer can specify various parameters of the safety system, such as the amount the seatbelts are retracted, the size and energy dissipation profile of energy absorbing mechanisms which allow the seatbelts to extend under load, the velocity, placement, and the timing and logic of airbag deployment. However, once selected, the options for control during a particular crash are usually limited to deciding whether or not to deploy various systems based on sensor data. So, for example, if the crash is below a certain threshold the airbags may not be deployed, or the seatbelt retractors may not be activated. Recently airbags have been given the capability of varying the force with which they deploy, sometimes by having two stages, sometimes by having venting systems. Such capabilities allow the safety system to respond to the situation created by a particular crash as opposed to designing a system to respond generally to all possible crashes. What is needed are energy management devices for seatbelts that can be continually adjusted as a crash event is occurring.

Summary of the Invention

[0004] The energy management device of this invention comprises a plurality of electromagnets positioned about a shaft that is mounted inside a seatbelt spool. The shaft is fixedly mounted, and the electromagnets, when energized, are repelled from the central shaft radially outwardly to engage the inside surface of a hub of the seatbelt spool. A high friction surface treatment of the inside surface of the hub and the outwardly facing surface of the electromagnets resists rotation of the hub over the electromagnets. The electromagnets are held against displacement by a series of radially extending ribs extending from the fixed shaft. By adjusting the amount of current supplied to the electromagnets, the amount of friction, and thus the amount of energy dissipated, can be controlled. This ability to control the amount of energy dissipated can be used to configure the energy management device to a particular vehicle or seatbelt position, and to adjust

the energy management device in real-time in response to sensor inputs during the crash.

[0005] In an alternative embodiment the energy management device can be used as an energy dissipation device with respect to movement of a D ring which supports a shoulder belt.

[0006] It is a feature of the present invention to provide an energy management device where the level of energy dissipation can be controlled electronically.

[0007] It is a further feature of the present invention to provide an energy management device where the level of energy dissipation is varied in real time in response to sensor inputs.

[0008] Further features and advantages of the invention will be apparent from the following detailed description when taken in conjunction with the accompanying drawings.

Brief Description of the Drawings

[0009] FIG. 1 is schematic isometric view of the seatbelt payout spool incorporating the energy dissipation device of this invention.

[0010] FIG. 2 is an enlarged fragmentary isometric view, partially exploded, of a portion of the energy dissipation device of FIG. 1.

[0011] FIG. 3 is an isometric view of a seatbelt spool mounted to a bracket and employing an alternative embodiment energy dissipation device of this invention.

[0012] FIG. 4 is a schematic isometric view of the application of an energy dissipation device mounted in a B pillar which allows forward movement of a D ring which supports a shoulder belt.

Detailed Description of the Invention

[0013] Referring to FIGS. 1- 4, wherein like numbers refer to similar parts, an energy management device 18 houses a seatbelt spool 20 as shown in FIG. 1. The seatbelt spool 20 is mounted about a fixed shaft 22. About the outer surface 24 of the fixed shaft are positioned a plurality of electromagnets 26, best shown in FIG. 2. Each electromagnet 26 has a magnetic pole piece 28 that has a rectangular groove 30 formed in the upper radial surface 32. A magnetic coil 34 is wound within the rectangular groove 30. The magnetic coil 34 in each of the electromagnets 26 is energized by electrical current supplied from a safety system controller 36. The electromagnets 26 are repelled from the central fixed shaft 22 bringing the upper surfaces 38 of the electromagnets 26 into engagement with the inside surface 40 of the spool 20.

[0014] A seatbelt 42 is wrapped around the spool 20 and extends to restrain a vehicle occupant during a crash in which an occupant (not shown) moves against the seatbelt 42. The seatbelt tension causes the spool 20 to rotate in the direction indicated by arrow 44. Rotation of the spool 20, and thus pay out of the seatbelt 42, is controlled by creating a braking action between the seatbelt spool 20 and the fixed shaft 22 by means of the electromagnets 26. The electromagnets 26 are held against rotation with respect to the fixed shaft 22 by ribs 46 that extend radially outwardly from the fixed shaft 22. The frictional engagement between the upper surfaces 38 of the electromagnets 26 and the inside surface 40 of the spool 20 may be enhanced by using an aggressive surface, or other surface features or treatments which can increase the coefficient of friction. A greatly increased coefficient of friction allows the total outward pressure produced by the electromagnets 26 to be substantially less than the torque imposed on the spool 20 by the seatbelt 42.

[0015] Because the braking action and thus the energy dissipation mechanism formed by the electromagnets 26 acting against the spool 20 can be modulated, a safety system controller 36 can acquire inputs from crash sensors 48. The inputs from the crash sensors 48 can be utilized with the inputs based on preprogrammed algorithms to control the energy dissipation with a real time profile which is most optimal for limiting loads to which the vehicle occupant is subjected during a crash. For example the load on a seatbelt may be increased linearly for a time and then held constant, or the load may increase linearly for a time, then held constant, then decreased linearly, and then be held constant at a lower value.

[0016] As shown in FIG. 3, the energy dissipation device 50 can be used by connecting the stator 54 to a bracket 74 on which a seatbelt spool 76 is mounted for rotation. The rotor 52 is then connected by the shaft 58 to the seatbelt spool 76 to produce controlled dissipation of energy as a seatbelt 78 is drawn from the spool 76. The energy dissipation device 50 is controlled by a safety system controller 80 that can receive input from sensors such as the crash sensor 82.

[0017] FIG. 4 shows the use of the energy dissipation device 50 where the rotor shaft 58 is connected to a spool 84 on which is wound a quantity of cable 86. The cable 86 extends over a pulley 88 in the B-pillar 89 of an automobile (not shown) to support a D ring 90 through which a shoulder belt 91 passes. When the seatbelt 91 is loaded during a crash, the D ring 90 pulls a cable 68 from the spool 84 mounted to the energy dissipation device 50. Again, the energy dissipation device 50 is connected to a safety system controller which can control the amount of braking action by supplying current to the magnetic coil 68 illustrated in FIG. 5.

[0018] It is understood that the invention is not limited to the particular construction and arrangement of parts herein illustrated and described, but

embraces all such modified forms thereof as come within the scope of the following claims.